Neutrino Experiments:

Physics goals can be addressed by a series of coordinated experiments that could provide new insights on the role of neutrinos in Nature.

Reactor Experiments

Nuclear reactors provide a prolific source of anti ν_e's. They have been recently used:

1) *with the Kamland detector in Japan to precisely determine Δm_{21}^2 and confirm solar neutrino oscillation parameters via anti-electron neutrino disappearance over long distances.*
2) *Earlier Chooz and Palo Verde reactor experiments, currently provide the best bound on θ_{13}, $\sin^2 2\theta_{13} < 0.15$.*
3) *Several new multi-detector reactor experiments under construction, a) Double Chooz in France, b) Daya Bay in China and c) Reno in South Korea, aim to significantly improve the sensitivity. They expect to have interesting results available starting in ~ 2010. By 2012 Daya Bay may start to approach $\sin^2 2\theta_{13} \approx 0.01$-$0.02$ sensitivity, and by 2014, Daya Bay hopes to reach 0.008 (90% CL). Those experiments offer the fastest and most direct way to determine $\sin^2 2\theta_{13}$.*

Once $\sin^2 2\theta_{13}$ is known, we can aggressively move forward on a major long term accelerator neutrino program designed to explore CP violation, the mass hierarchy and potential new physics effects via $\nu_\mu \rightarrow \nu_e$ appearance oscillations. The value of that mixing angle will also provide guidance regarding the best detector technology with which to proceed.

- ***The Panel strongly endorses the planned reactor neutrino experiments and U.S. participation in them. Funding should be a very high priority and the funding profile, particularly for Daya Bay, should be such as to allow them to reach their design sensitivity for $\sin^2 2\theta_{13}$ as soon as possible.***

2. Long Baseline Accelerator Neutrino Oscillations

Traditional accelerator produced muon neutrino and antineutrino beams can be used to study oscillations via ν_μ disappearance or $\nu_\mu \rightarrow \nu_e$ appearance. Because of their higher energies, much longer oscillation distances are required for accelerator neutrino beams (relative to reactors). So, for example, the ongoing Fermilab MINOS experiment employs a 735km baseline with its detector located in the Minnesota

Soudan mine.

MINOS has, so far, produced the best measurement of Δm_{32}^2 via ν_μ disappearance.
It has limited $\nu_\mu \rightarrow \nu_e$ appearance capabilities, but may be able to constrain θ_{13}

Principal physics reasons for an ambitious experimental program in neutrino physics and proton decay is based on construction of large detectors. E.g. 1) a series of massive water Cherenkov detectors located deep underground (e.g. 4850 ft) in the Homestake Mine of the South Dakota Science and Technology Authority (SDSTA); 2) the engineering design of the (underground) chambers to house the Cherenkov
detector modules; and 3) the conceptual design of the water Cherenkov detectors themselves for this purpose.

The program with a beam from FNAL because of the high intensities currently available from the Main Injector with modest upgrades and The possibility of tuning the primary proton energy over a large range from 30 to 120 GeV .
On the other hand the beam from BNL over the larger distance will produce very large matter effects, CP and new physics beyond CP violation, can be better tested with that configuration.

CP violation physics.